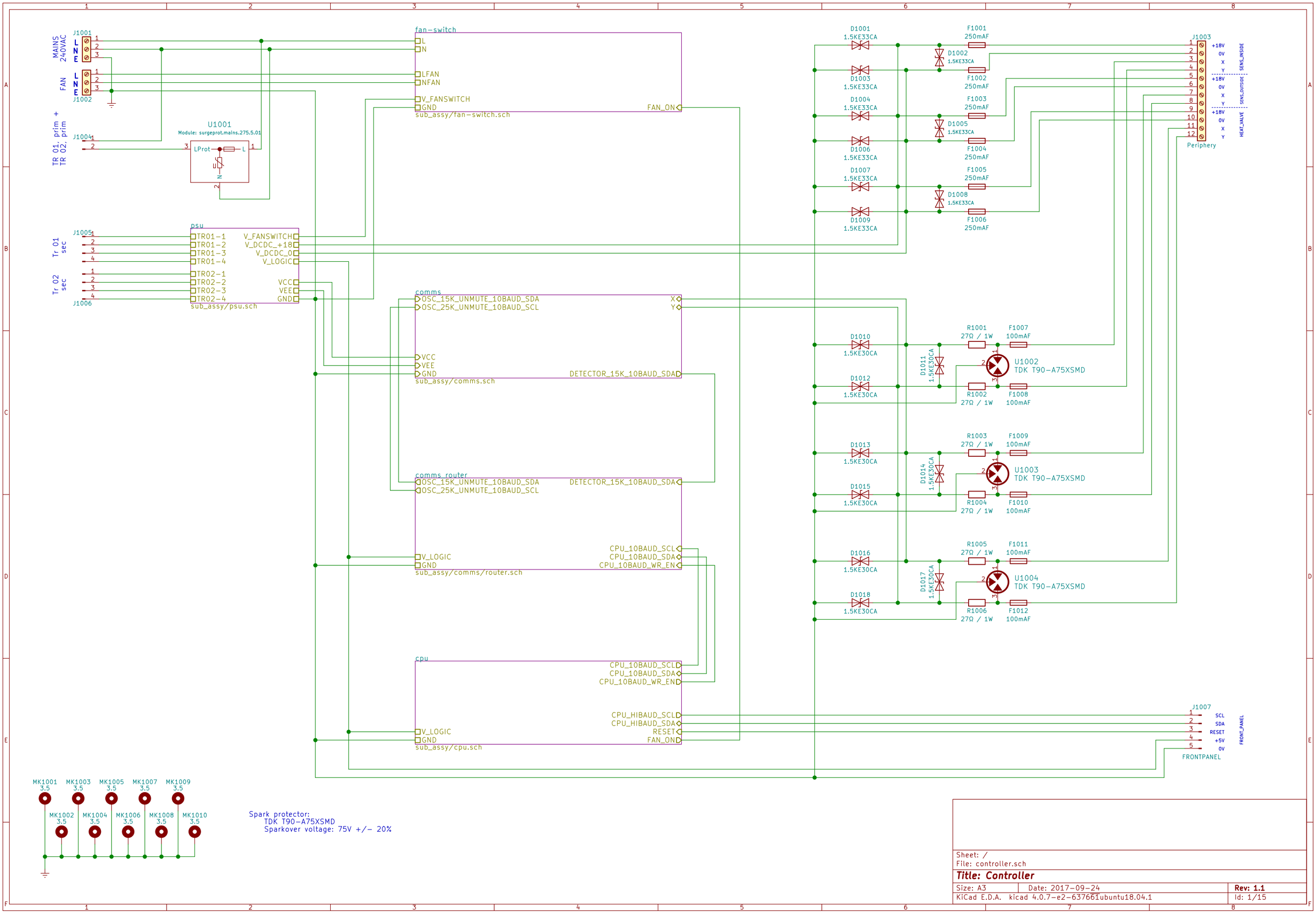
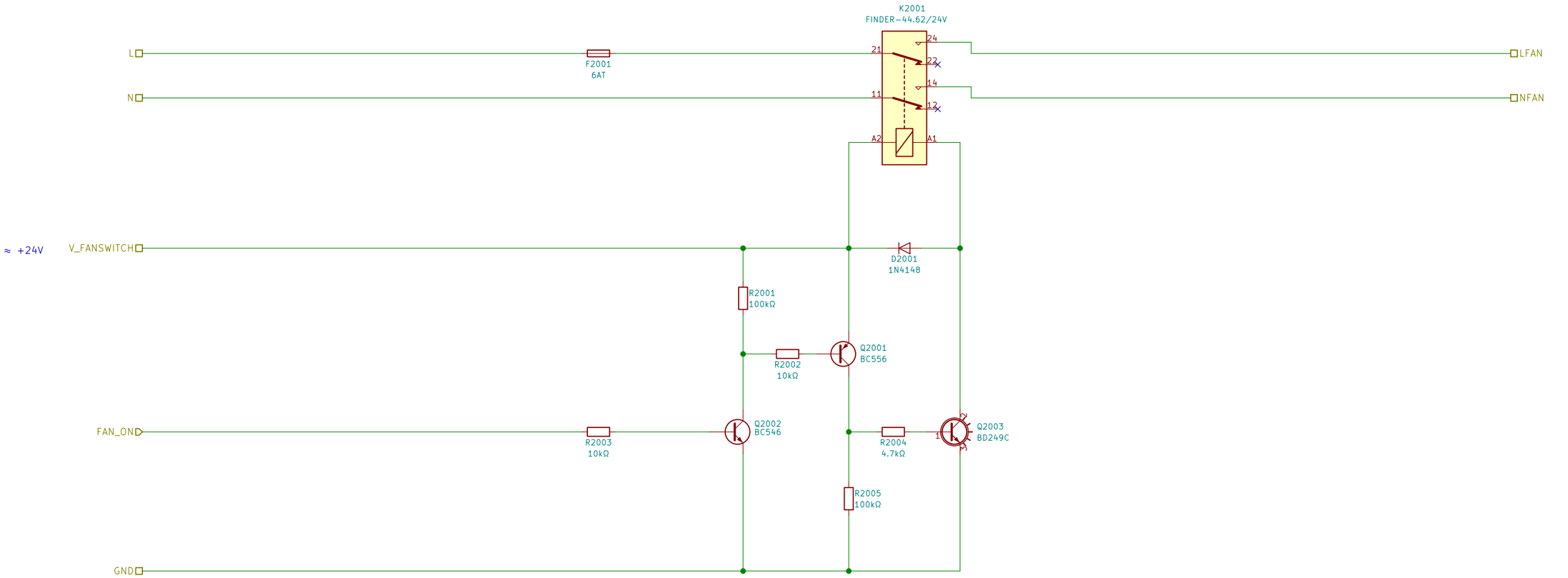
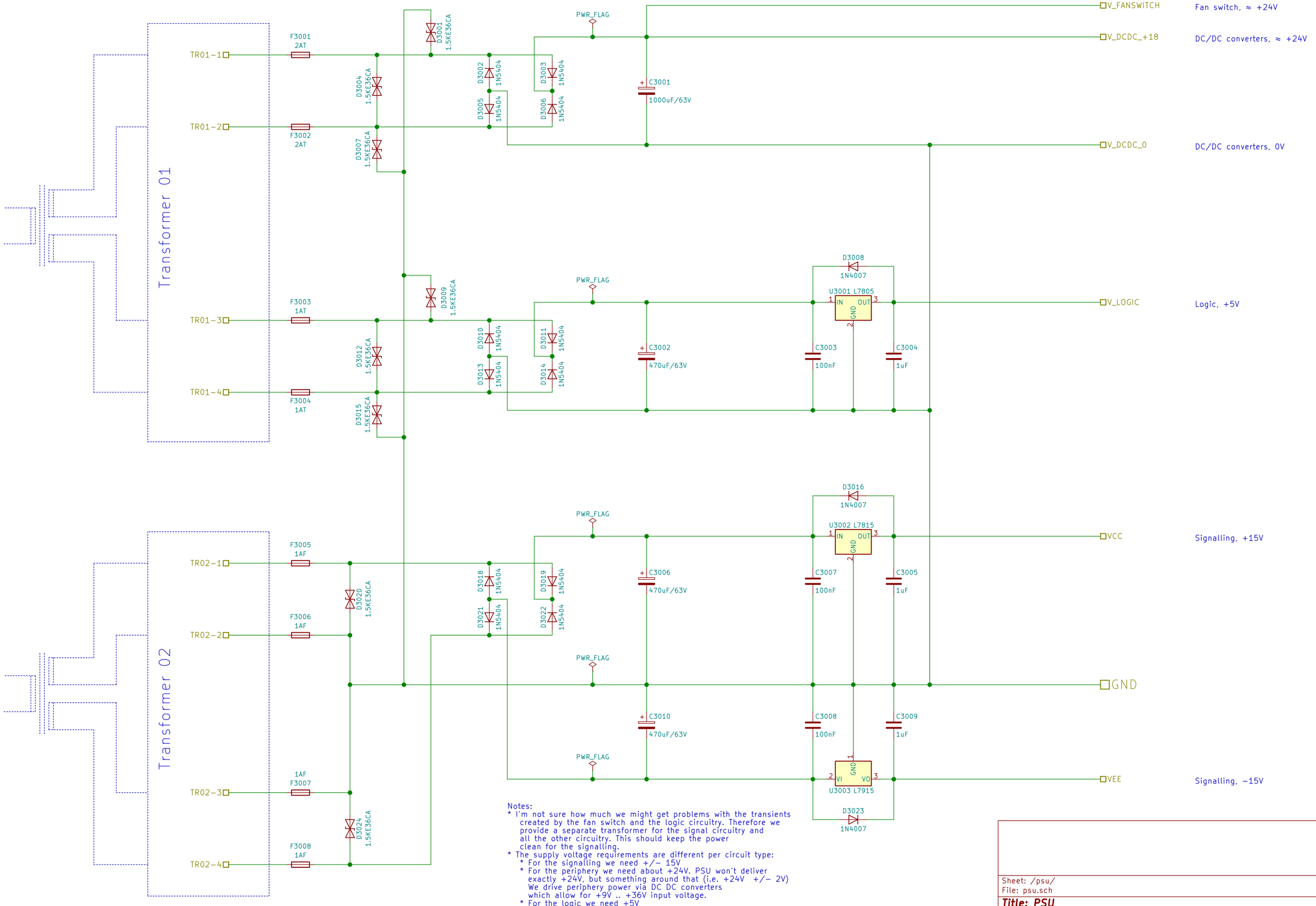

MAINS 240VAC
J1001
L
N
FAN
J1002
TR 01. prim +
TR 02. prim
J1004
U1001
Module: surgeprot.mains.275.5.01
LProt
L
N
fan-switch
L
N
LFAN
NFAN
V_FANSWITCH
GND
FAN_ON
sub_assy/fan-switch.sch
psu
J1005
Tr 01 sec
Tr 02 sec
J1006
TR01-1
TR01-2
TR01-3
TR01-4
TR02-1
TR02-2
TR02-3
TR02-4
V_FANSWITCH
V_DCDC_+18
V_DCDC_0
V_LOGIC
VCC
VEE
GND
sub_assy/psu.sch
comms
OSC_15K_UNMUTE_10BAUD_SDA
OSC_25K_UNMUTE_10BAUD_SCL
X
Y
VCC
VEE
GND
DETECTOR_15K_10BAUD_SDA
sub_assy/comms.sch
comms router
OSC_15K_UNMUTE_10BAUD_SDA
OSC_25K_UNMUTE_10BAUD_SCL
DETECTOR_15K_10BAUD_SDA
V_LOGIC
GND
CPU_10BAUD_SCL
CPU_10BAUD_SDA
CPU_10BAUD_WR_EN
sub_assy/comms/router.sch
cpu
CPU_10BAUD_SCL
CPU_10BAUD_SDA
CPU_10BAUD_WR_EN
V_LOGIC
GND
CPU_HIBAUD_SCL
CPU_HIBAUD_SDA
RESET
FAN_ON
sub_assy/cpu.sch
D1001
1.5KE33CA
D1002
D1003
D1004
D1005
D1006
D1007
D1008
D1009
F1001
250mAF
F1002
F1003
F1004
F1005
F1006
J1003
Periphery
+18V
0V
X
Y
SENS_INSIDE
SENS_OUTSIDE
HEAT_VALVE
D1010
1.5KE30CA
D1011
D1012
D1013
D1014
D1015
D1016
D1017
D1018
R1001
27Ω / 1W
R1002
R1003
R1004
R1005
R1006
F1007
100mAF
F1008
F1009
F1010
F1011
F1012
U1002
TDK T90-A75XSMD
U1003
U1004
J1007
SCL
SDA
RESET
+5V
0V
FRONT_PANEL
FRONTPANEL
MK1001
MK1002
MK1003
MK1004
MK1005
MK1006
MK1007
MK1008
MK1009
MK1010
3.5
Spark protector:
TDK T90-A75XSMD
Sparkover voltage: 75V +/- 20%
Sheet: /
File: controller.sch
Title: Controller
Size: A3
Date: 2017-09-24
Rev: 1.1
KiCad E.D.A. kicad 4.0.7-e2-637661ubuntu18.04.1
Id: 1/15



Sheet: /fan-switch/
File: fan-switch.sch

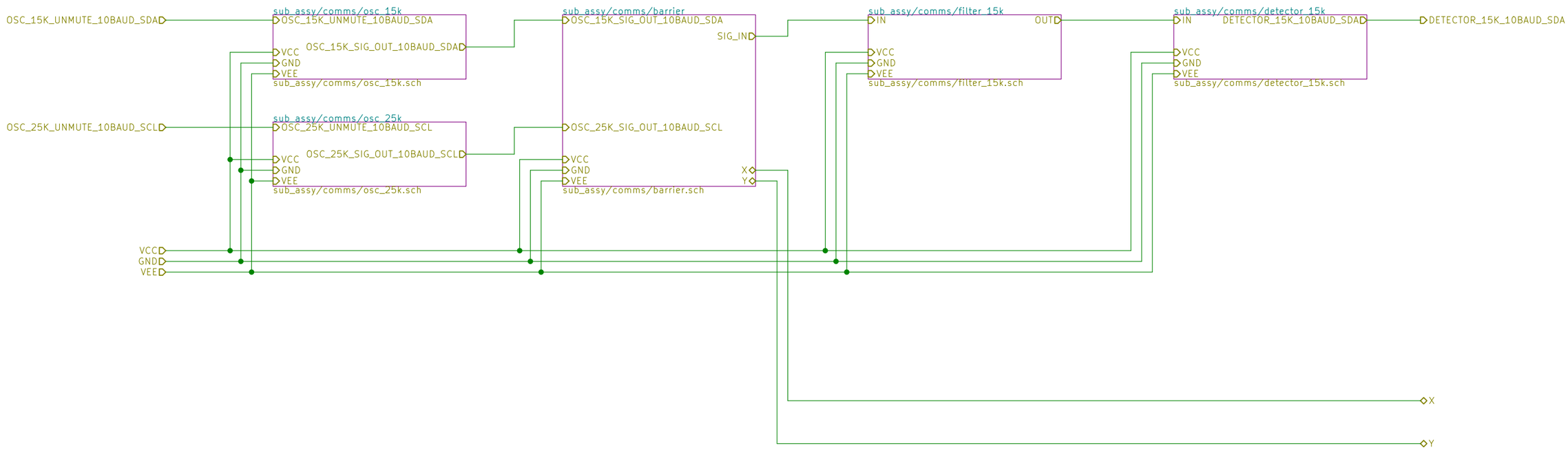
Title: Fan switch

Size: A3	Date: 2017-10-01	**Rev: 1.1**
KiCad E.D.A. kicad 4.0.7-e2-637661ubuntu18.04.1		Id: 2/15

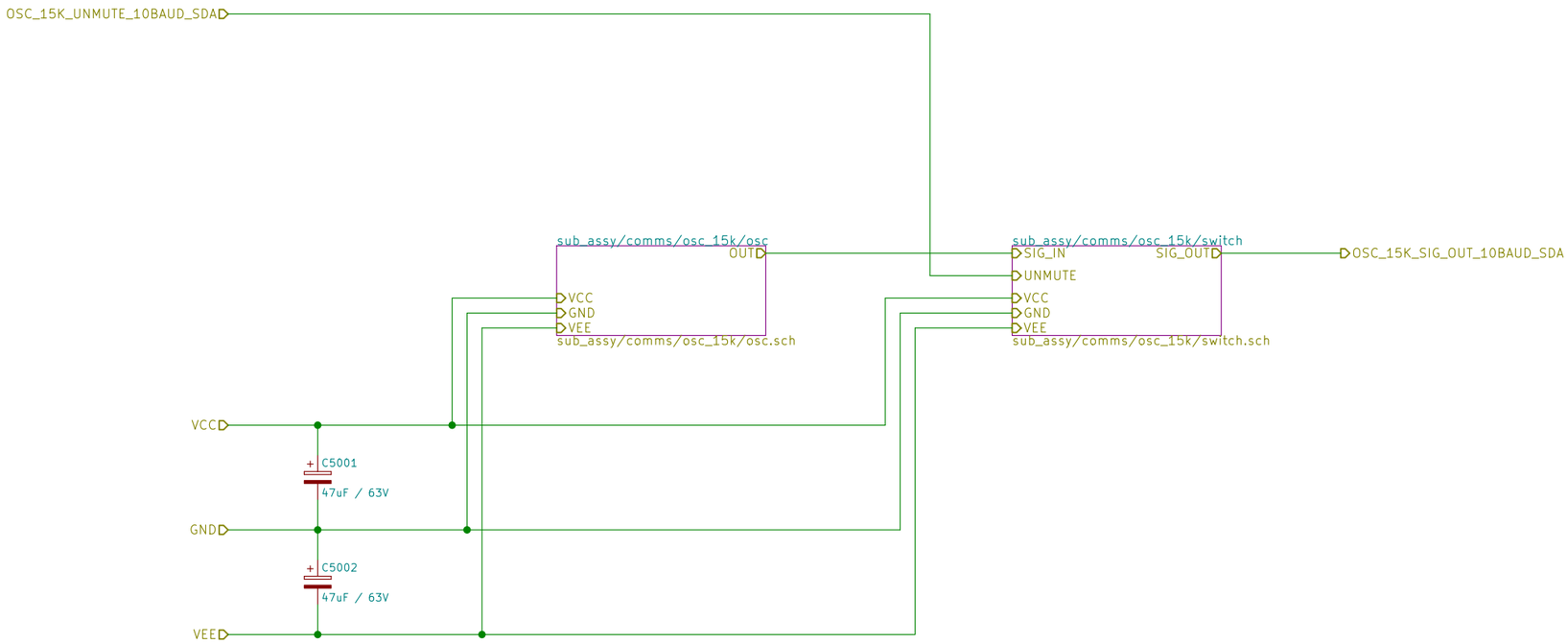


Notes:
* I'm not sure how much we might get problems with the transients created by the fan switch and the logic circuitry. Therefore we provide a separate transformer for the signal circuitry and all the other circuitry. This should keep the power clean for the signalling.
* The supply voltage requirements are different per circuit type:
  * For the signalling we need +/− 15V
  * For the periphery we need about +24V. PSU won't deliver exactly +24V, but something around that (i.e. +24V +/− 2V) We drive periphery power via DC DC converters which allow for +9V .. +36V input voltage.
  * For the logic we need +5V
  * For the fan switch we need +24V +/− 2V.

Sheet: /psu/		
File: psu.sch		
Title: PSU		
Size: A3	Date: 2017-09-24	**Rev: 1.1**
KiCad E.D.A. kicad 4.0.7-e2-6376~61ubuntu18.04.1		Id: 3/15



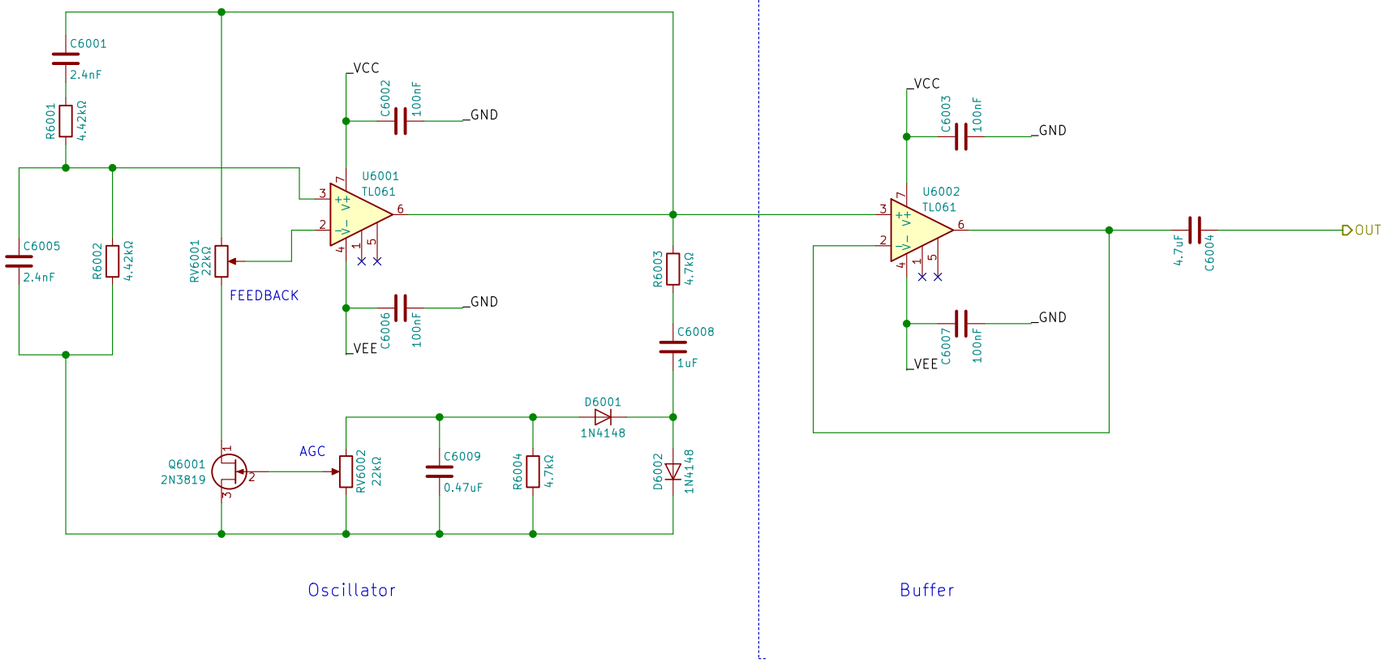
Sheet: /comms/		
File: comms.sch		
Title: comms module		
Size: A3	Date: 2017-10-08	**Rev: 1.0**
KiCad E.D.A. kicad 4.0.7-e2-637661ubuntu18.04.1		Id: 4/15



Sheet: /comms/sub_assy/comms/osc_15k/
File: osc_15k.sch

Title:

Size: A3	Date:	**Rev:**
KiCad E.D.A. kicad 4.0.7-e2-637661ubuntu18.04.1		Id: 5/15



VCC — VCC

GND — GND

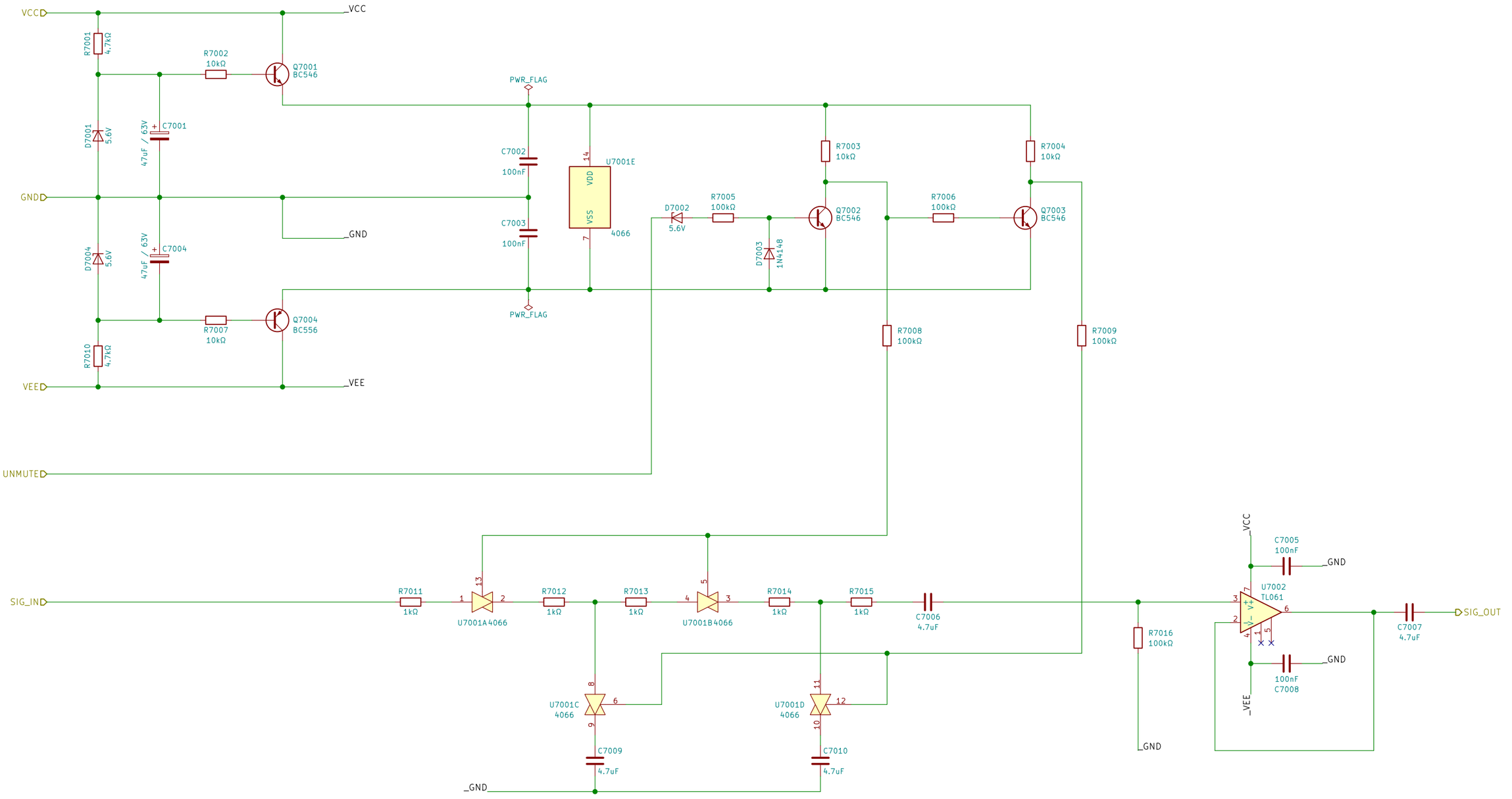
VEE — VEE

Wien bridge oscillator, 15kHz, AGC stabilized

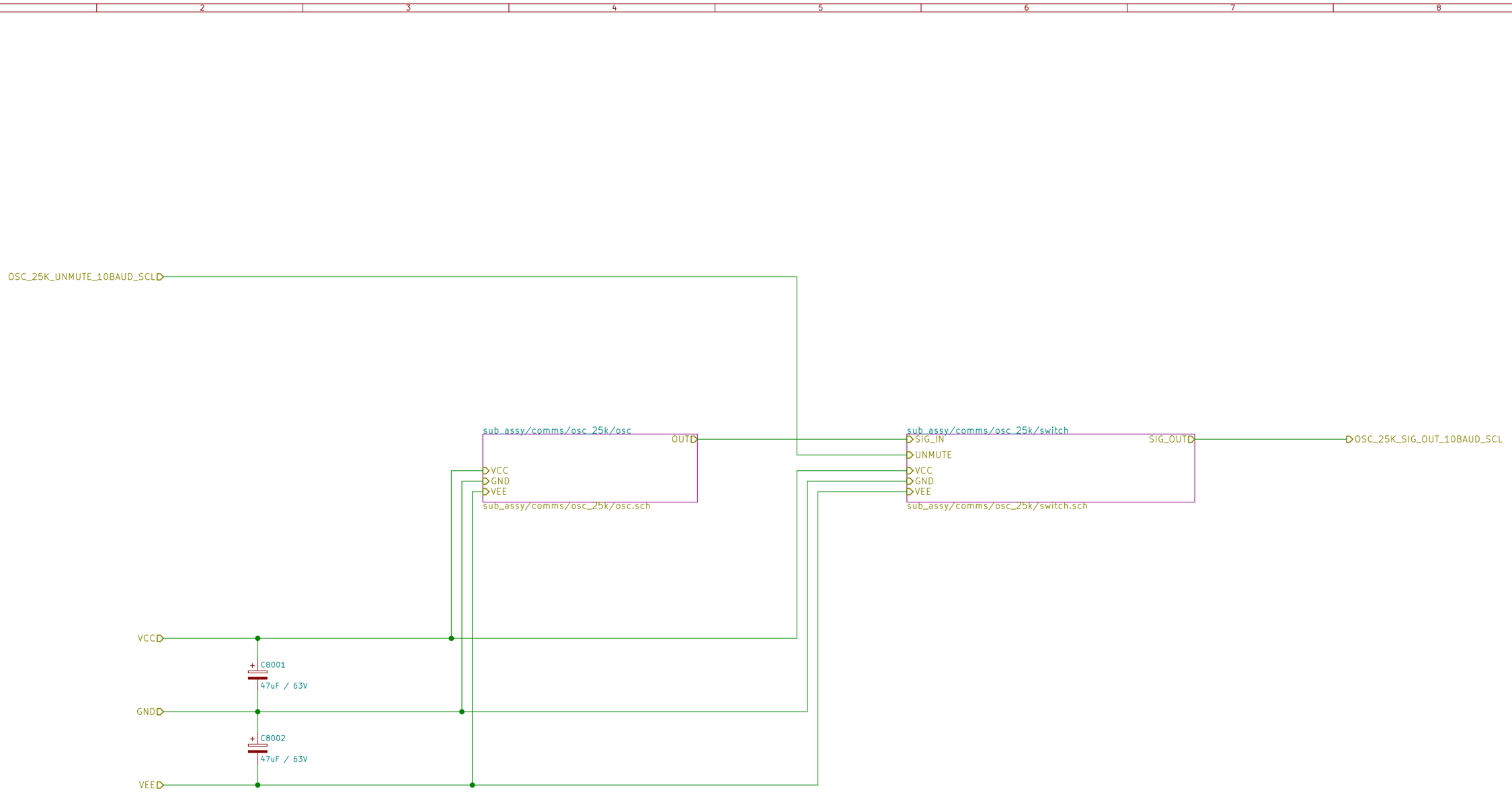
Sheet: /comms/sub_assy/comms/osc_15k/sub_assy/comms/osc_15k/osc/
File: osc.sch

Title: Oscillator, 15kHz

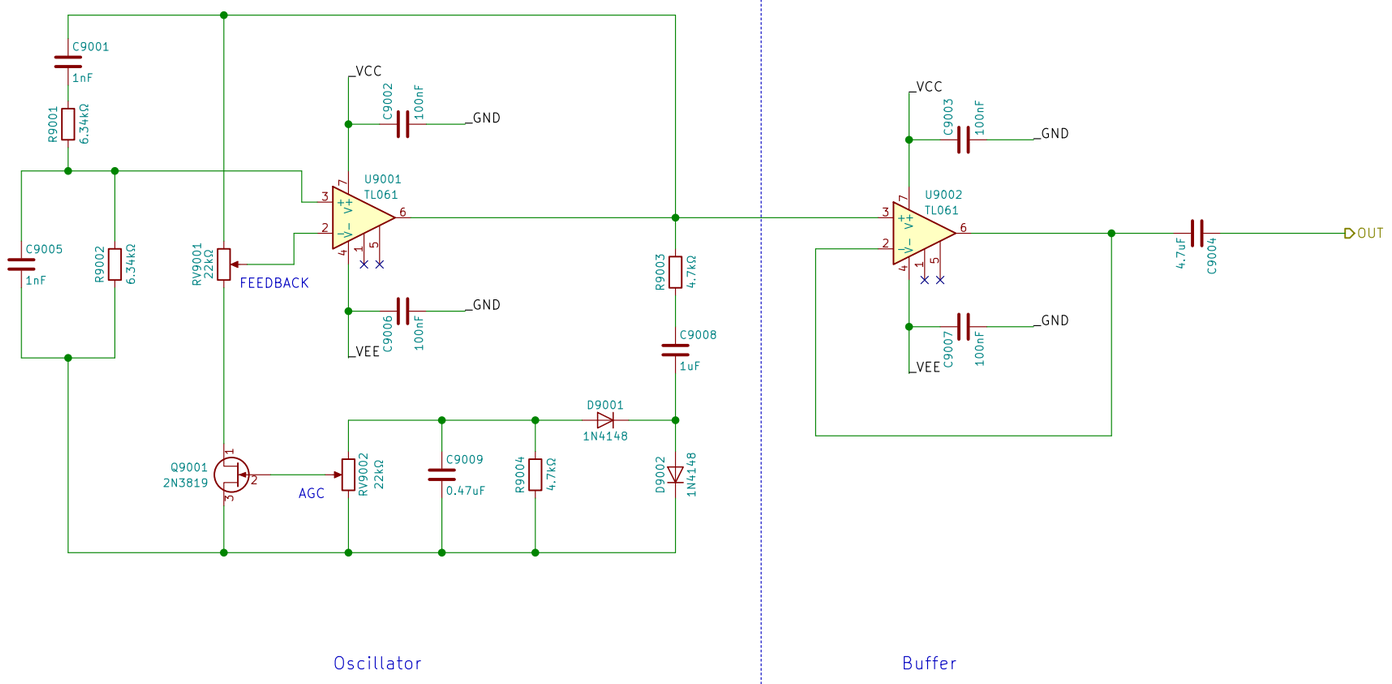
Size: A3	Date: 2017-11-12	**Rev: 1.1**
KiCad E.D.A. kicad 4.0.7-e2-637661ubuntu18.04.1		Id: 6/15



Sheet: /comms/sub_assy/comms/osc_15k/sub_assy/comms/osc_15k/switch/		
File: switch.sch		
Title: Signal Switch		
Size: A3	Date: 2017-11-26	**Rev: 1.1**
KiCad E.D.A. kicad 4.0.7-e2-637661ubuntu18.04.1		Id: 7/15



Sheet: /comms/sub_assy/comms/osc_25k/		
File: osc_25k.sch		
Title:		
Size: A3	Date:	**Rev:**
KiCad E.D.A. kicad 4.0.7-e2-637661ubuntu18.04.1		Id: 8/15



VCC — VCC

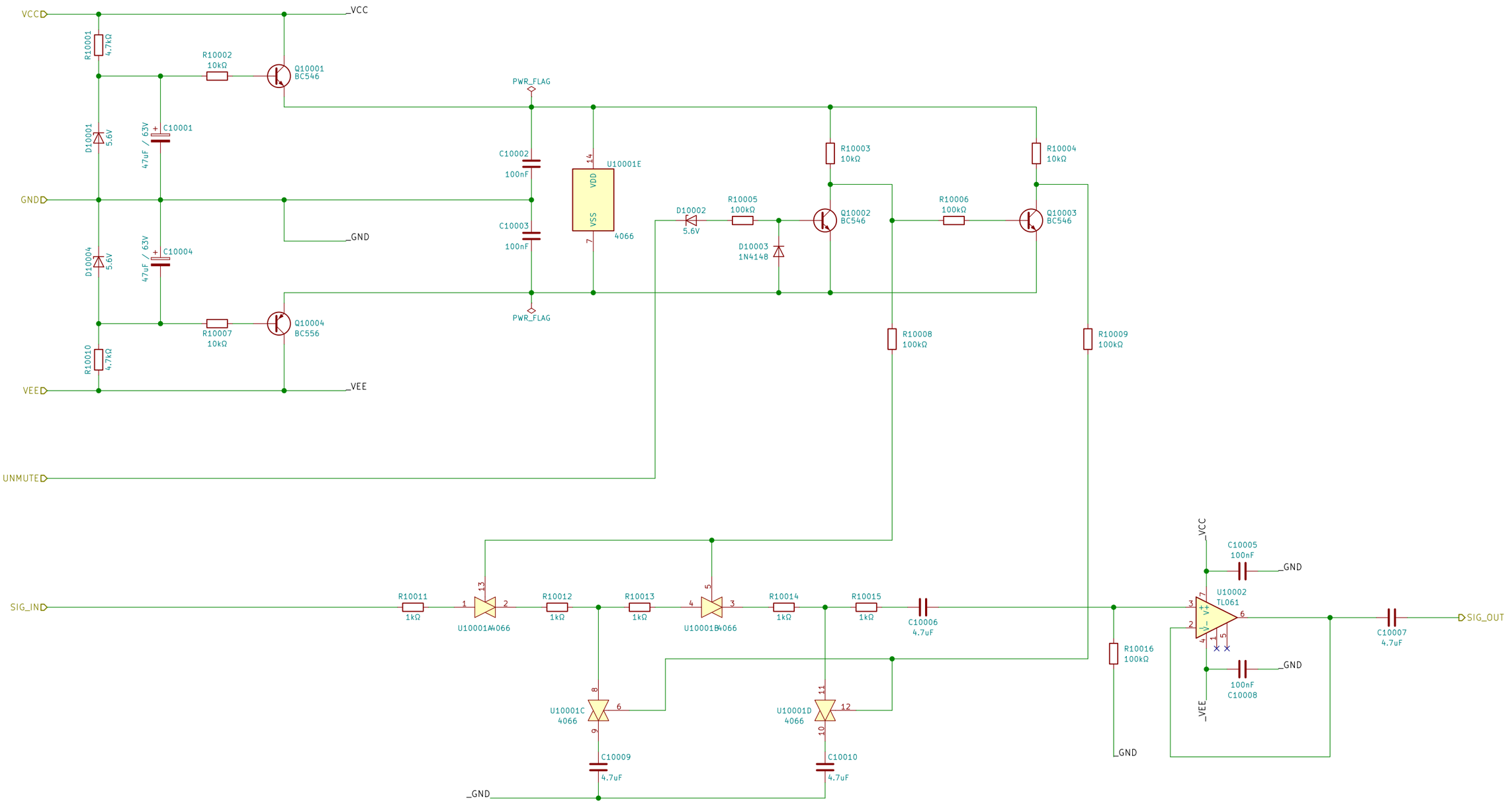
GND — GND

VEE — VEE

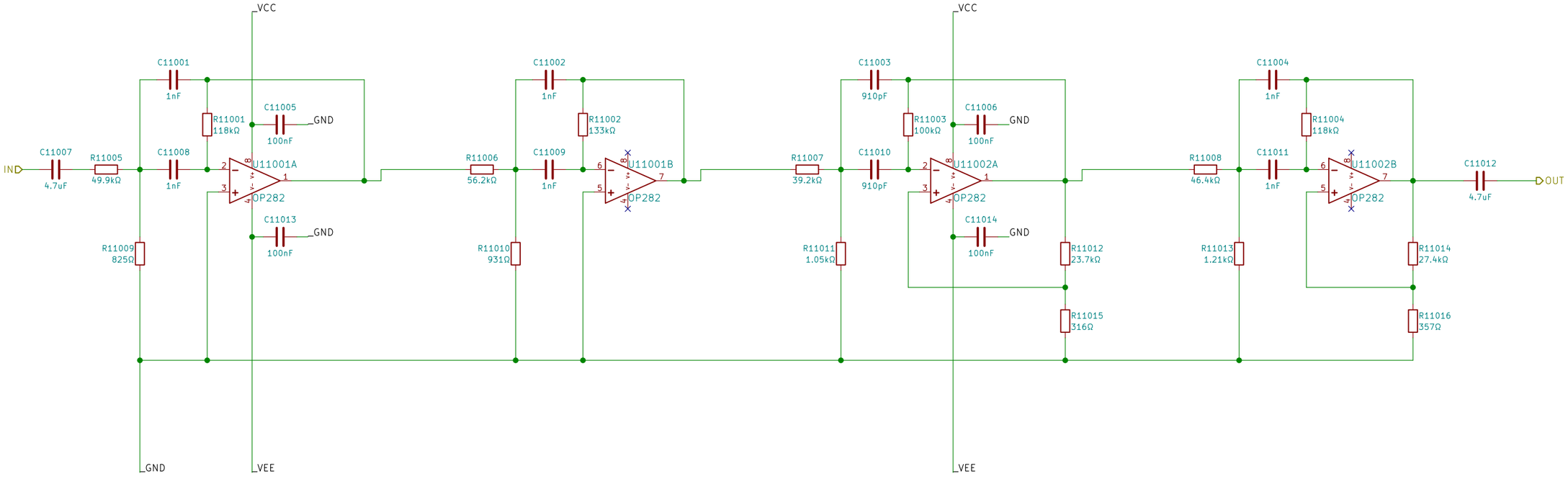
Sheet: /comms/sub_assy/comms/osc_25k/sub_assy/comms/osc_25k/osc/
File: osc.sch

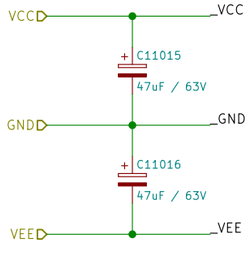
Title:

Size: A3	Date:	**Rev:**
KiCad E.D.A. kicad 4.0.7-e2-637661ubuntu18.04.1		Id: 9/15

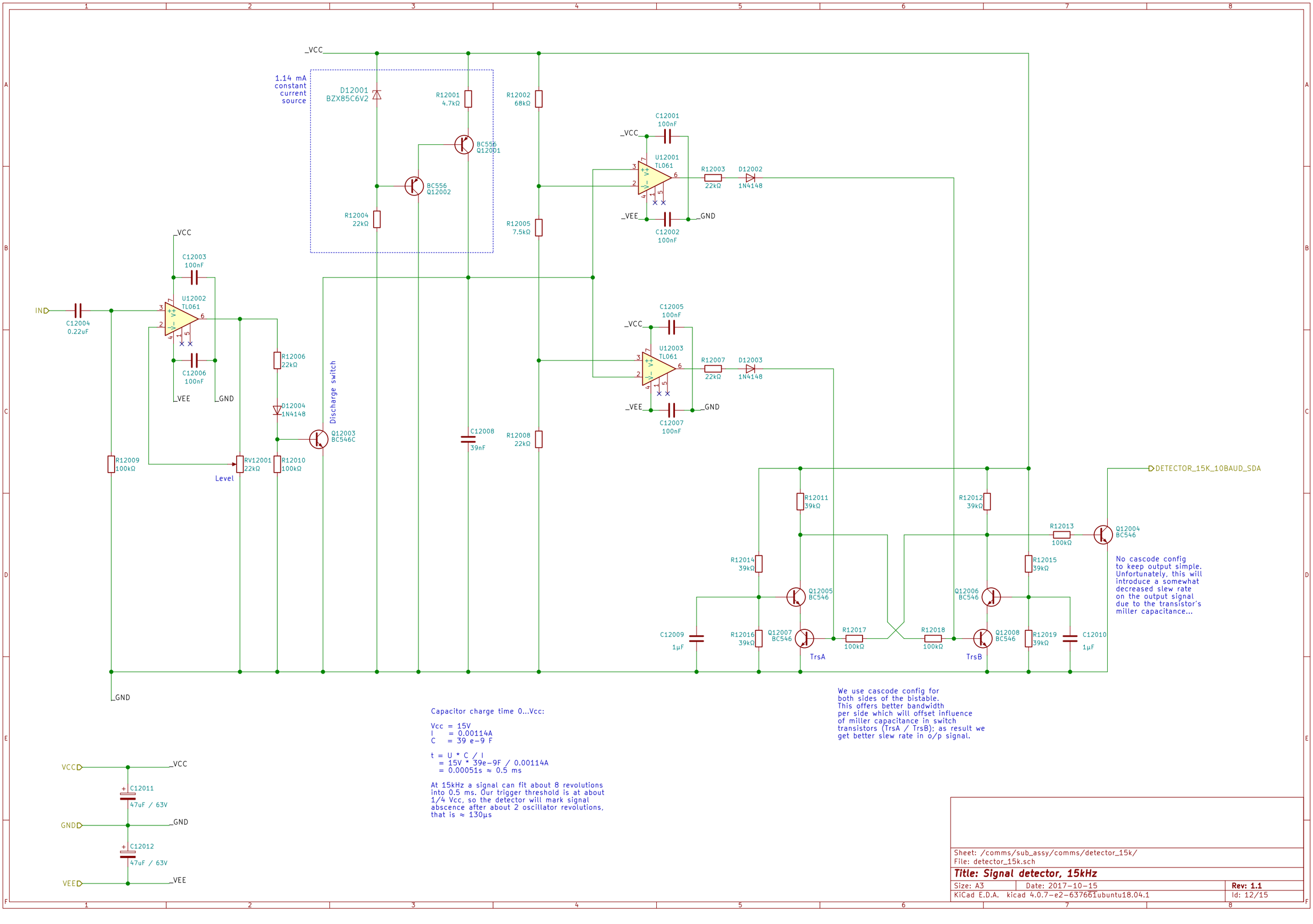


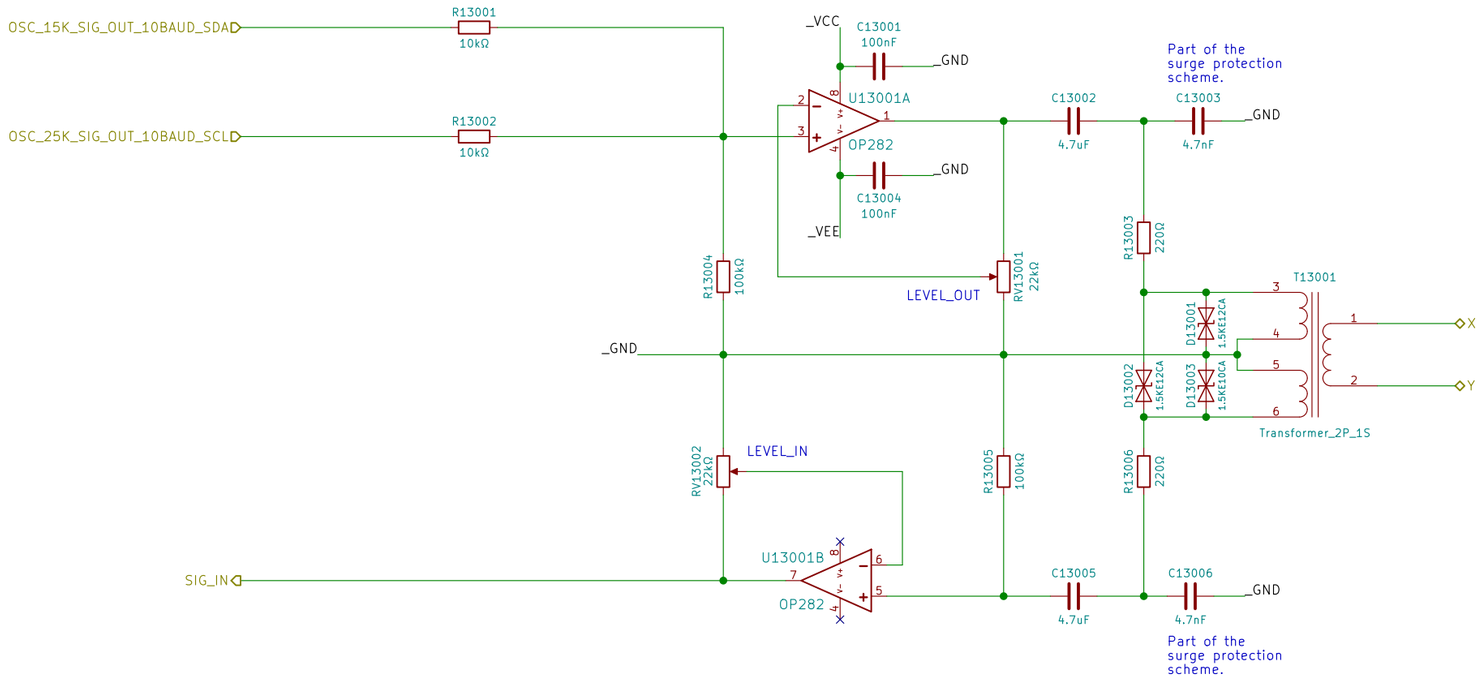
Sheet: /comms/sub_assy/comms/osc_25k/sub_assy/comms/osc_25k/switch/		
File: switch.sch		
Title:		
Size: A3	Date:	**Rev:**
KiCad E.D.A. kicad 4.0.7-e2-637661ubuntu18.04.1		Id: 10/15

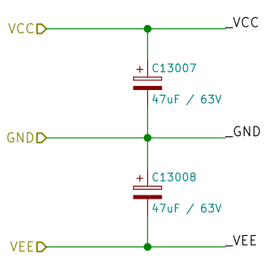




Sheet: /comms/sub_assy/comms/filter_15k/		
File: filter_15k.sch		
Title: Bandpass filter, 15k		
Size: A3	Date: 2017-10-15	**Rev: 1.1**
KiCad E.D.A. kicad 4.0.7-e2-637661ubuntu18.04.1		Id: 11/15


_VCC
1.14 mA
constant
current
source
D12001
BZX85C6V2
R12001
4.7kΩ
BC556
Q12001
BC556
Q12002
R12004
22kΩ
R12002
68kΩ
R12005
7.5kΩ
R12008
22kΩ
C12008
39nF
C12001
100nF
U12001
TL061
R12003
22kΩ
D12002
1N4148
C12002
100nF
_VEE
_GND
C12003
100nF
U12002
TL061
IN
C12004
0.22uF
C12006
100nF
R12006
22kΩ
D12004
1N4148
Discharge switch
Q12003
BC546C
R12009
100kΩ
RV12001
22kΩ
Level
R12010
100kΩ
C12005
100nF
U12003
TL061
R12007
22kΩ
D12003
1N4148
C12007
100nF
DETECTOR_15K_10BAUD_SDA
R12011
39kΩ
R12012
39kΩ
R12013
100kΩ
Q12004
BC546
R12014
39kΩ
R12015
39kΩ
Q12005
BC546
Q12006
BC546
C12009
1µF
R12016
39kΩ
Q12007
BC546
TrsA
R12017
100kΩ
R12018
100kΩ
Q12008
BC546
TrsB
R12019
39kΩ
C12010
1µF
No cascode config
to keep output simple.
Unfortunately, this will
introduce a somewhat
decreased slew rate
on the output signal
due to the transistor's
miller capacitance...
We use cascode config for
both sides of the bistable.
This offers better bandwidth
per side which will offset influence
of miller capacitance in switch
transistors (TrsA / TrsB): as result we
get better slew rate in o/p signal.
Capacitor charge time 0...Vcc:
Vcc = 15V
I = 0.00114A
C = 39 e-9 F
t = U * C / I
= 15V * 39e-9F / 0.00114A
= 0.00051s ≈ 0.5 ms
At 15kHz a signal can fit about 8 revolutions
into 0.5 ms. Our trigger threshold is at about
1/4 Vcc, so the detector will mark signal
abscence after about 2 oscillator revolutions,
that is ≈ 130µs
VCC
C12011
47uF / 63V
GND
C12012
47uF / 63V
VEE
Sheet: /comms/sub_assy/comms/detector_15k/
File: detector_15k.sch
Title: Signal detector, 15kHz
Size: A3
Date: 2017-10-15
Rev: 1.1
KiCad E.D.A. kicad 4.0.7-e2-637661ubuntu18.04.1
Id: 12/15

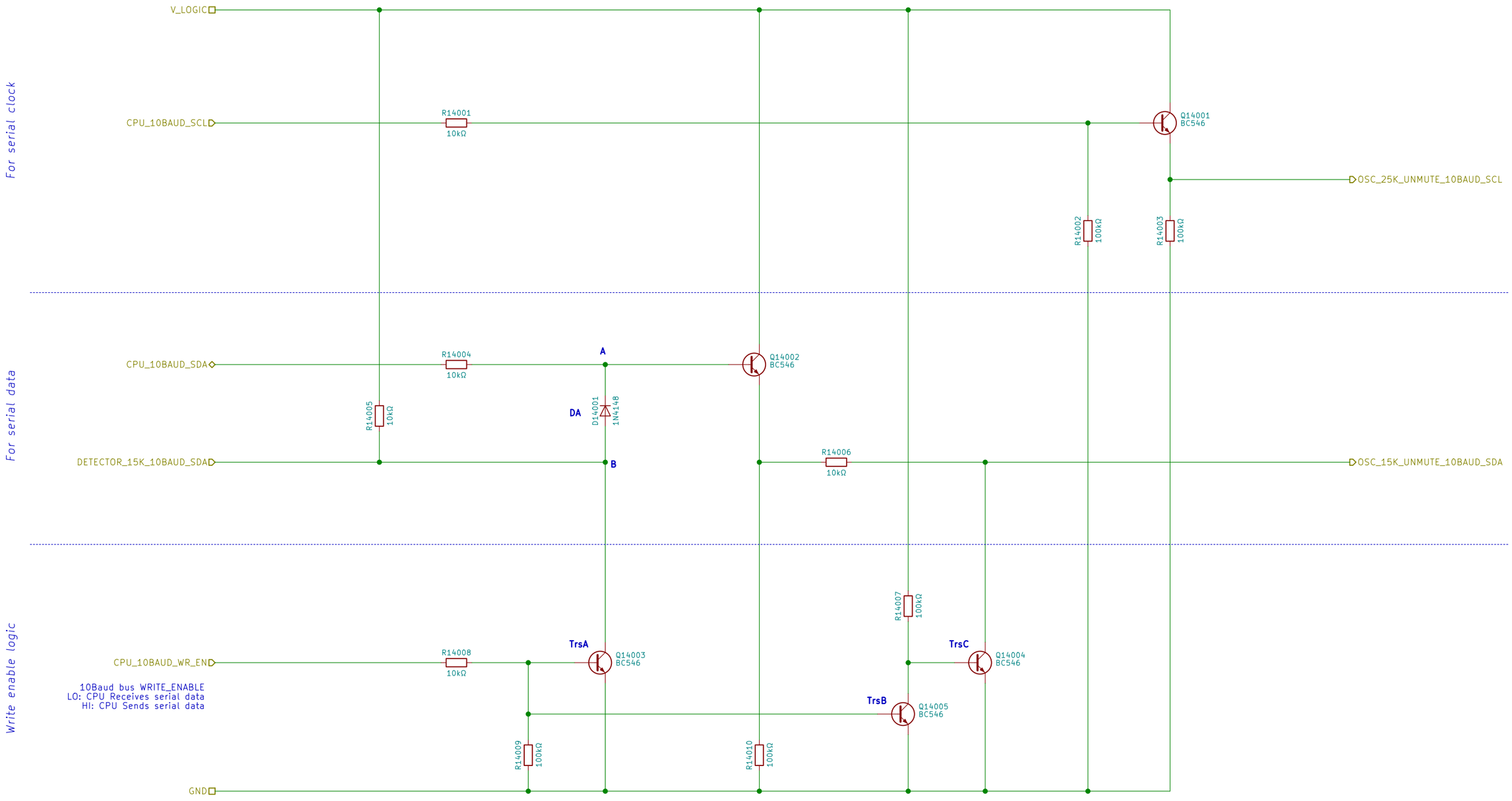




Sheet: /comms/sub_assy/comms/barrier/
File: barrier.sch

Title: Transformer Barrier module

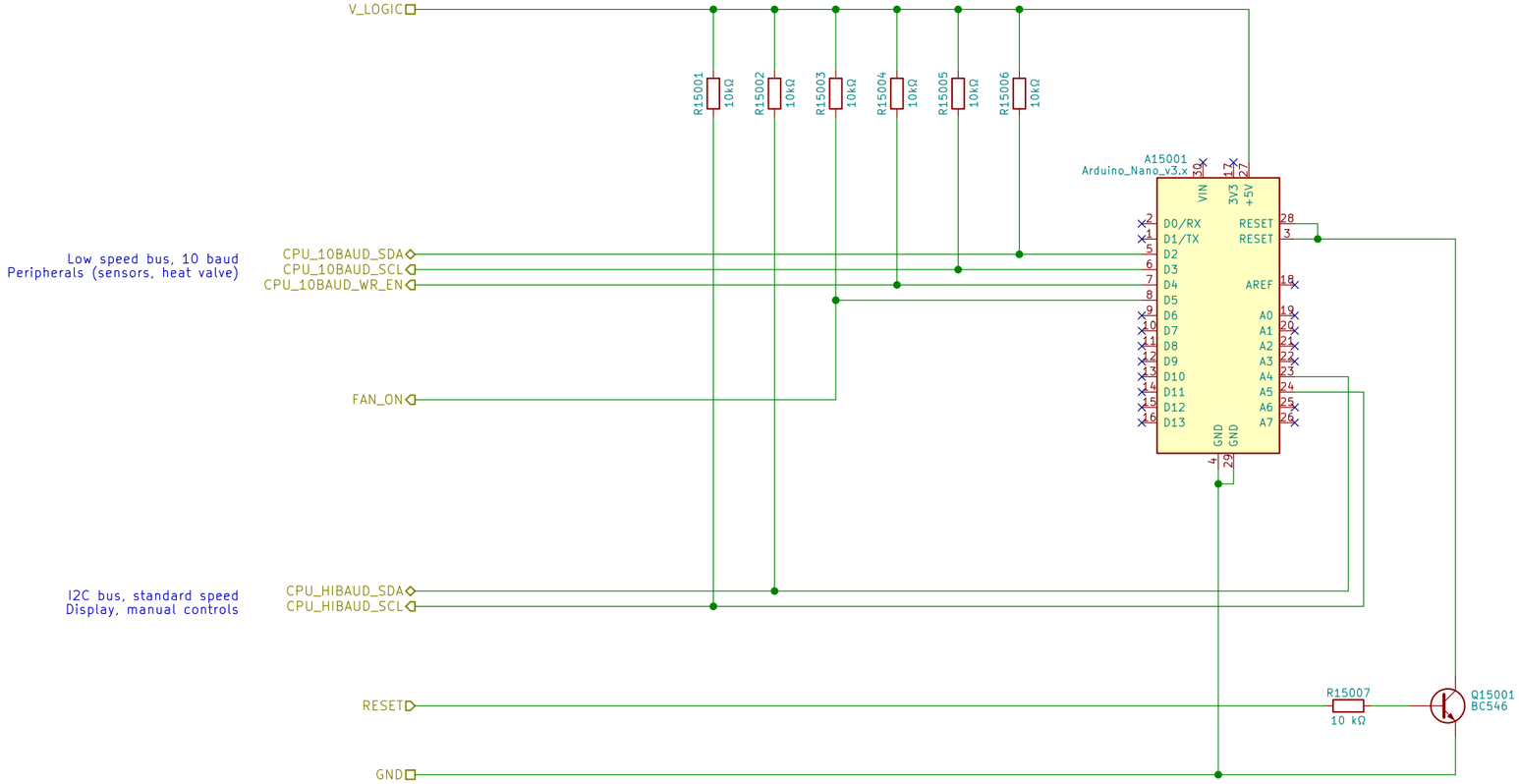
Size: A3	Date: 2017-10-08	**Rev: 1.0**
KiCad E.D.A. kicad 4.0.7-e2-637661ubuntu18.04.1		Id: 13/15



Notes:
* The communication with the periphery implements ideas from the I2C bus design with the addon that we encode the logic levels with AC signals between controller and peripherals. For the clock we use a 25kHz signal, for the data we use a 15kHz signal. Signal abscent = logic 0, Signal present = logic 1
* The design is geared at EMC robustness, i.e. we employ surge protection between controller and periphery. Equipment operates in an area with thunderstorms and near lightning strikes.
* As a trade-off, comms between controller and periphery can only handle very low data rates. It's no problem in this application as we are handling very small amounts of data (a few bytes per transferral) when receiving and sending data from / to the peripherals.
* Serial clock is unidirectional as the clock is generated by the controller with all peripheral devices listening.
* Serial data is bidirectional as the CPU both receives and transmits data from / to the periphery devices.
* DETECTOR_15K_10BAUD_SDA is connected to an open-collector output. It seemed best to put the pullup resistor here.

WR_EN (Write-enable) logic
* *WR_EN low (about 0V)*
  * *TrsA open, TrsB open, TrsC closed.*
  * *OSC_15K_UNMUTE_10BAUD_SDA pulled to GND (0V), i.e. 15kHz oscillator will be muted.*
  * *CPU_10BAUD_SDA follows A follows B follows DETECTOR_15K_10BAUD_SDA.*
* *WR_EN high (about 5V)*
  * *TrsA closed, TrsB closed, TrsC open.*
  * *DA will be either closed when A is on GND potential or reverse polarized when A is on V_LOGIC potential, i.e. B and A will be isolated from each other.*
  * *DETECTOR_15K_10BAUD_SDA pulled to GND (0V) i.e. 15kHz detector remains silent.*
  * *OSC_15K_UNMUTE_10BAUD_SDA follows A follows CPU_10BAUD_SDA.*
* *Legend*
  * *Trs... open: Transistor, CE, not conducting*
  * *Trs... closed: Transistor, CE, conducting*

Router: 10Baud bus I/O		
Sheet: /comms_router/ File: router.sch		
Title:		
Size: A3	Date: 2018-02-25	**Rev: 1.0**
KiCad E.D.A. kicad 4.0.7-e2-637661ubuntu18.04.1		Id: 14/15



CPU module

Sheet: /cpu/
File: cpu.sch

Title:

Size: A3	Date:	**Rev:**
KiCad E.D.A. kicad 4.0.7-e2-6376~~61~~ubuntu18.04.1		Id: 15/15